

REVIEW

Role of Bamboo in Sustainable Development

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Bamboo a well-known timber grass is popular since years for its multipurpose uses, from a food source to a building material. Due to its vast use bamboo possesses an enormous potential to improve the rural economy and would play a vital role in establishing the sustainable development. With the advancement of the modern era people are forgetting the wide scope of usage for bamboo. The present review aims to cover present and future role and prospective of Bamboo in the economy of the country.

Keywords: Sustainable, Delicacy, Versatility.

INTRODUCTION

Bamboo, one of the fastest growing plants on earth is a member of family Poaceae and subfamily Bambusoideae (ISFR 2011). Bamboo is popularly known as “Green Gold of the forest” because of its varied applications. Absence of woody xylem and secondary growth, the hollow inter nodal region of a stem, scattered vascular bundle characterize bamboo as monocot plant. Bamboo found to have 75 genera and 1250 species in the world, among which 23 genera and 75 species exists in India (Tamang et al., 2013). India is the second richest country in bamboo genetic resources after China. Though India has the largest area under bamboo, which is estimated around 9.6 million hectares, the yield per ha is estimated around 0.4 tons, which is very low in comparison to other countries like China, Malaysia, Costa Rica etc. According to mythological beliefs Bamboo is said to be a crop of sacrifice. By looking towards the practical aspects bamboo is a

highly economic important plant having versatile uses. The present review deals with the versatility in pattern of distribution and uses of Bamboo.

DISTRIBUTION PATTERN

Bamboo is widely distributed throughout India while maximum part is covered by Arunachal Pradesh which constitutes area of 16,083 sq km and minimum in Haryana i.e 19 km sq (ISFR 2011) Figure 1. Bi climatically bamboo diversity falls in three major regions comprises of 21 bamboo species in tropical forests, 28 species in sub-tropical forests, 12 species in temperate forests, while sub-alpine forest has 6 species and alpine vegetation has 3 species (Tamang et al., 2013; Raizada and Chatterjee 1956). State-wise distribution pattern of bamboo in India has been described in Table 1.

BAMBOO TAXONOMY AND ANATOMY

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Like any other plant Bamboo has its branches

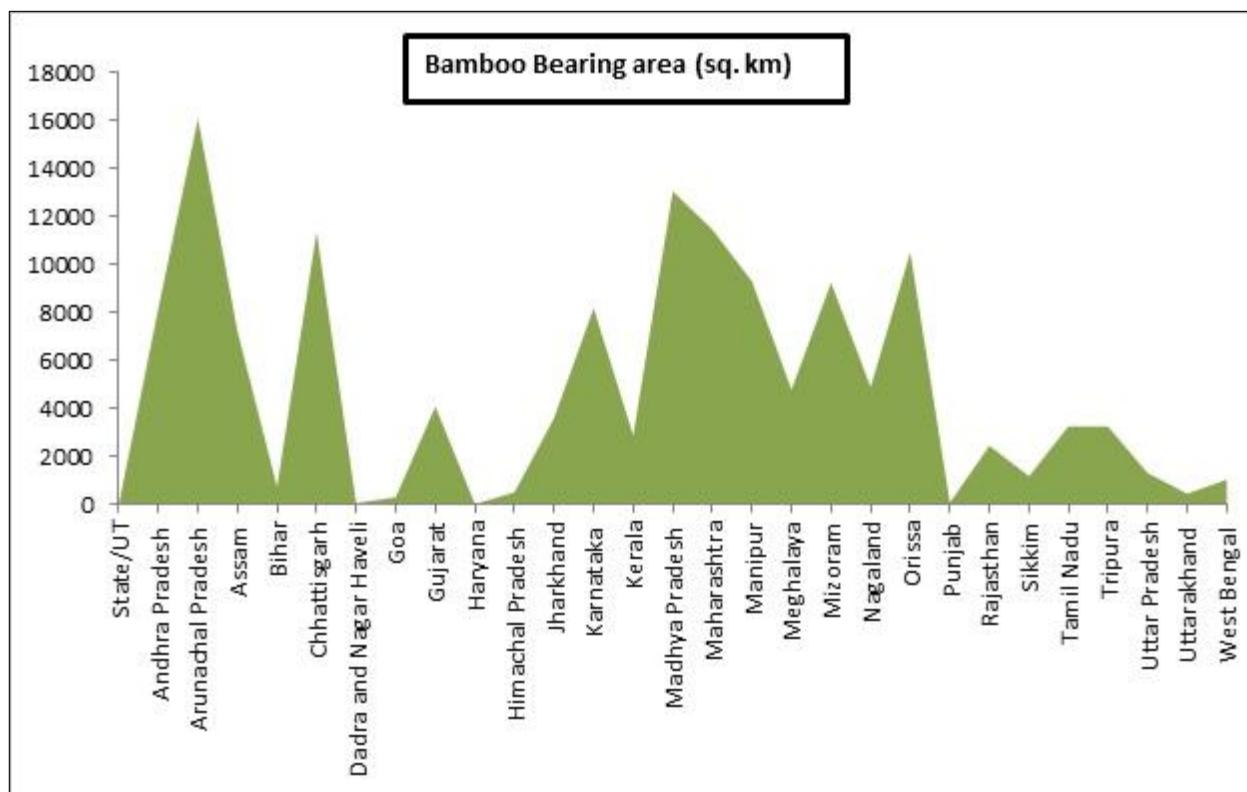


Figure 1. Area-Wise distribution pattern of Bamboo in India.

Source: The data for this graphical representation had been retrieved from Indian State of Forest Report, 2011.

leaves rhizomes roots and flower, additionally it is gifted with Culms and bamboo fibers which provide it economic importance (Bisen 1985). Multiple branches are originated from a single bud located at node position. Leaves of bamboo plant possess an anatomy of blade, sheath and ligule. The blade shaped anatomy of leaves help plant in photosynthesis (Mustafa et al., 2011; Sharma and Nirmala, 2015). Rhizomes are horizontal stems which are spread throughout the soils and absorb nutrient which provide energy for rapid and massive growth of plants. Roots of bamboo are basically to anchor the culm to the ground (Wenyue 1981). Culms are the most visibly distinguishable feature of a bamboo plant. Culms can vary in size, shape, color, and even smell, most bamboo species seldom flower (Maya and Narasimhamurthy, 2015; Abdlatif and Tamizi, 1993). The typical flowering interval can be decades long. The longest flowering interval is of 130 years found in Japanese Timber (*Phyllostachys bambusoides*). Bamboo fiber another important part of this plant comprises of cellulose, hemicelluloses and lignin. Protein, fats, pectin,

tannin and ash are the other important constituents which are important for physiological activity of bamboo plant. The presence of lignin provides stiffness and color to the plant. Bamboo occurs in two propagation form that is clump forming type and non-clump forming type (Razak 2007). Non-clumping types are referred as monopodial types and clumping type are referred as sympodial type. Monopodial types emerged from the parent plant and mainly erect and long while sympodial type are short root structures and generally form discrete clumps.

Based on geographic location and phenotypic variability, bamboo is a highly diverse plant. Hence to assess genetic variation and precise identification molecular marker has been playing a vital role (Goyal et al., 2014). Various molecular markers were used innumerable for taxonomic characterization includes Restriction fragment length polymorphisms (RFLP), Amplified fragment length polymorphism (AFLP), Sequence-Characterized Amplified Regions (SCARs), Inter-simple sequence repeat (ISSR), Expressed

Sequence Tag - Simple Sequence Repeat (EST-SSR), Transposons. (Andersson and Chase, 2001; Sungkaew et al., 2009; Hodkinson et al., 2002; Zhou, 2010; DAS et al., 2007; Senet, 2014). With respect to future aspects molecular genetics is a fast moving field and many new techniques are likely to be emerge having unseen strengths and limitation.

ECONOMY OF BAMBOO (USES)

Bamboo possesses number of advantageous effect for relieving many of the social and environmental problems of many countries (Quintans, 1998; Mehra and Mehra, 2007). Multiple uses of bamboo and its great versatility makes it a good alternative of timber, hence often refer as "poor man's timber" due to its wide range of uses in human economy wide range of names had been coined for bamboo such as Vietnamese call it "My Brother", for Chinese it is "Friend of the people" and in India it is popularly known as "Green Gold". Bamboo plant is useful in its every age such as plant less than of 30 days are good for eating , 6-9 month old plants are suitable for making baskets, 2- year old plant are used for bamboo board and laminating , 3-6 year old plant are best for construction (Tamang et al., 2013, Aniket, 2013; Hossain et al., 2015). Bamboo is multidisciplinary plant which is used as in building material, for making furniture and decorative arts , bamboo is serve as delicacy, bamboo are even used in medicines.

BAMBOO AS BUILDING MATERIAL

Bamboo poses great potentiality for making environmental friendly, low cost, sustainable house to meet the need of people (Terai and Mnam, 2012). Using bamboo as construction material reduces the consumption of steel and cement and worthy alternative for making eco and economic friendly house.

A study conducted by a group of scientists has shown that bamboo elasticity and tensile strength is equal to that of steel, hence it is a valuable alternative of steel in building material (Bhardwaj et al., 2014; Bhagat et al., 2013; Xiao et al., 2010). Despite having high efficiency, bamboo house has its drawback; that is they are susceptible to termite attack.

BAMBOO AS DELICACY

Bamboo shoots have low contents of fat, high in potassium, carbohydrate, vitamins and dietary fibers. It serves as delicacy in several part of the world. Edible shoots are found in many of bamboo species but very less of them are utilized (Chongtham et al., 2011). *Bambusa.balcooa*, *B. bambos*, *B. kingiana*, *B. nana*, *B. nutans*, *B. pallida*, *B. polymorpha*, *B. tulda*, *B. vulgaris* var. *vulgaris*, *Chimonobambusa hookeriana*, *Dendrocalamusasper*, *Dendrocalamus. giganteus*, *D. hamiltonii*, *D. hookerii*, *D. longispathus*, *D.membranaceus*, *D. sikkimensis*, *D. strictus*, *Gigantochloa rostrata*, *Melocannabaccifera*, *Phyllostachys bambusoides*, *Schizostachyum capitatum*, *Teinostachyum wightii*, *Thrysostachys siamensis*, *T. oliveri*, *Schizostachyum dullooa* are the Indian species used for their shoots (Bhatt et al., 2005; Tamang, 2008). These young bamboo shoots have been considered as gourmet items in the western world where these are available only as imported canned products (McClure, 1996; Baiyi et al., 2006). Traditionally, non-standardized, seasonal region specific with little value addition, consumption pattern has been observed in most of the countries. Hence there exists a great market opportunity for food based industries to process bamboo in an organized manner. Bamboo juice, bamboo tea and Bamboo beer are some of the beverages made by processing bamboo leaves although they are not as much commercialized as were bamboo shoots (Bhatt, 2005; Choudhury et al., 2012; Lu et al., 2005; Qiu, 1992).

BAMBOO FURNITURE

In the last few year market faced an increasing demand of bamboo furniture. This type of furniture holds great potentiality in terms of aesthetically designs and cost effectiveness. Many well-designed and elegant products made out of bamboo are available which includes sofa, chairs, tables, dining tables, cots. Bamboo boards are also used to make table tops and school, office and showroom furniture. Light weightiness is an additive feature of bamboo furniture. Besides furniture many stylish handicraft such as lampshades, standing lamps, baskets, showpieces and decorative corners had been seeking a great attention of crowd.

Table 1. State-wise distribution pattern of bamboo in India.

S/NO	Bamboo species	Local Name	Distribution	Uses
1.	<i>Bambusa balcooa Roxb.</i>	Bhaluka, Baruwa, Wamnah, Beru, Dhanu, Bans, Bhalu, Bans, Oti, Vuteya , Awuti, Avuthi, Barak	North Eastern India including Nagaland, Meghalaya, Tripura, Assam, West Bengal and Bihar extending to Eastern Uttar Pradesh	House construction, scaffolding, making ladders and props for small bridges, For Agarbatti sticks and in pulp and paper industries.
2	<i>Bambusa bambos</i> Voss	Katabah, Kotabanh, Saneiba, Kanday bans	Kotoha/ Found throughout India up to 1200m altitude	House construction, panel production and fencing, scaffolding, handy craft, furniture, cooking utensils, etc.
3	<i>Bambusanutans</i> Wall ex Munro	Mokal, Mallo, Kali, Deobanh, Jatie, makal, Utang, Mal Bans, Rungazumi.	North East India, Orissa and Bengal	House construction, paper mat and poles.
4	<i>Bambusa pallida</i> Munro	Bijli, Jowa, Bijuli, Makal, Tenang, Ushken, Teero, Watoi Mizoram, Makal	North East India, Bhutan and Myanmar	Baskets, mats, toys, wall plates, screen and wall hangers.
5	<i>Bambusa tulda</i> Roxb	Jati, Mirtinga, WatiOwati, Koraincho bans, Rawthing, Mirtinga	North Eastern India and West Bengal	Handicraft, paper and structural purpose bamboo boards and composites.
6	<i>Bambusa vulgaris</i> Var. <i>Vulgaris</i> Schrad ex Wendle	Telabanh, Tanstibanh, Lam-Saneibi, Babal, Basni, Bheriu, Bakal , Vairui, Jai	North East India and Natural forest in central India	Pulp and paper industries, constructions, scaffoldings, Fencing, handicrafts, shoots as vegetable etc.
7	<i>Dendrocalamus asper</i> Backer ex Heyne	Kako, Hate, Kakobanh, Unap, Aotsü, Choya	India, Bhutan, Nepal, Myanmar and Thailand, West, Central and Eastern India in the lower hills from Simla	Basket, mats ropes, paper and pulp industries.

Table 1. Contd.

8	<i>Dendrocalamus giganteus</i> Munro	Worra, BorKako, Maribob, Bhalu Bans, Warok, Rawnal	Malaya and Myanmar, North eastern state and west Bengal	House building, fencing. In Arunachal Pradesh Mishmi tribe use this bamboo mainly as water container and also uses for paper and pulp and vegetable products are prepared from tender shoots.
9	<i>Dendrocalamus hamiltonii</i> Ness and Arn ex Munro	Kako/Hate, Kakobanh, Unap Aotsü, Choya Bans/Ban Bans/ Dhungrey bans Phulrua, Pecha	India, Bhutan, Nepal, Myanmar and Thailand	Construction, making of basket, mats ropes, as container for water, milk and other eatable items.
10	<i>Dendrocalamus strictus</i> Ness	Shalbanh, Latti bans, Tursing, Lath bans, Karail, Salia, Malebamboo	China, Indonesia, Java, Malaya, Myanmar, Nepal and Thailand	Constructional purposes, musical instruments, furniture, as food items and siliceous matters are used in traditional medicines in India.
11	<i>Melocanna baccifera</i> Kurz	Muli, Tadordort, Taraibanh, Muli, Maubiwa, Turiah, Mautak, Muli	India, Myanmar, Bangladesh, Assam, Manipur, Meghalaya, Mizoram, Tripura, Sikkim and West Bengal	Roofing walls of huts and handlooms
12	<i>Ochlandra travancorica</i> Benth	Kar-etta, Eeral/Eera-Kalli, Elephant grass	Throughout Western Ghats and South Kerala	Fishing rod and handicrafts.
13	<i>Oxytenanthera parvifolia</i> Brandis ex Gabel	Hill Jati	Myanmar, Assam, Mizoram	Baskets, mats and huts

Source: The data for this tabular representation had been retrieved from Hand Book on Bamboo, National Bamboo Mission, Under the Ministry of Agriculture Government of India.

BAMBOO AS MEDICINE

Since ancient time onward bamboo extracts are traditionally used to cure some human illness. Bamboo extract are useful in controlling diabetes and cholesterol (Singhal et al., 2013; Dharmananda 2004). Various studies had shown that bamboo extract possess anti-inflammatory, antioxidant and antimicrobial activity (Hu et al., 2000; Jung et al., 2005) .Tabasheer (or tabashir); bamboo sapare, these are bamboo extracts used in remedies for children's feverish disorders and epilepsy . (Gaur, 1985; Yang, 2002). Various anatomy of bamboo such as burnt powder of roots are highly useful in bleeding gums and arthritis, Leaf possess the property of antileprotic, anticoagulant and used in haemoptysis (Shukla et al., 2012), Lophaterumgracile and black bamboo leaves are useful in urinary retention with blood in urine while leaves of pleiblastusamarus are useful in treating fidgeting and lung inflammation.. Bambusaarunidinacea is popular ayurvedic medicinal plant. It possesses variety of properties such as antiinflamatory, antiulcer, anthelmintic, antioxidant etc (Lu et al., 2005). Seeds of bamboo plants are laxative and useful constipation and urinary discharge. Buds of Bambusa bambos are reported to have estrogenic activity. A good anti-inflammatory drug can produce in combination of herbal product (methanol extract of Bambusaarudinace) with modern medicine which will be useful for long-term treatment of chronic inflammatory conditions.

MISCELLANEOUS

Bamboo Cars and bamboo clothes and even bamboo statues are some of innovations which can do wonders in finance markets in coming years.

RESEARCH AND DEVELOPMENT ASPECT OF BAMBOO

Having a potential economic status in market bamboo needs a quality research (Gaur, 1985). Mass multiplication, quality seed, biofertilizers for bamboo, long term viability of seeds are some of the research area to be focused on. Many research laboratories of India are engaged in bamboo tissue culture (Secthalakahmi et al., 1983) for its

conservation such as Tropical Botanical Garden and Research Institute has 48 species while Kerala Forest Research Institute has 45 species. Forest Research institute has 35 species. Government of India has introduced modular course of Bamboo development which are redesigned by Directorate General of Employment and Training, Ministry of Labor and Employment (DGET) for developing the skilled of bamboo product among people. Some educational institutes had implemented the courses on bamboo production. Dayalbagh Education Institute Agra (Deemed University) India, has introduced the ten-week modular course entitled Bamboo Application Technology. This modular course has been designed to generate personnel for the bamboo sector, i.e. bamboo based building, furniture, handicrafts, bamboo-based industries, etc. Centre for Green Building Material and Technology (CGBMT) Bangalore, has initiated a Post Graduate Diploma in Bamboo Application Technology. Dayalbagh Education Institute Agra is working under a joint venture with CGBMT for generating the man force to promote bamboo technology in India. Indian Council of Forestry Research and Education (ICFRE) jointly with Kerala Forest Research Institute (KFR) carry out practices for development of bamboo on degraded land. Technology Information Forecasting and Assessment Council (TIFAC) and Indian Institute of Technology (IIT) Bombay, are working on process of production of activated carbon from bamboos.

GOVERNMENT LEGISLATION

Keeping a mind frame of harnessing the maximum benefits of bamboo crops, Indian government are implementing scheme with mutual support of local people. National Bamboo Mission (NBM), a very good example is running by department of Agriculture and Cooperation, Ministry of Agriculture. NBM is a sub scheme under the major scheme Mission for Integrated Development of Horticulture. NBM is centralized scheme of Indian government for promoting the overall growth of Bamboo plant in India. This mission deals with the strategies such as adopting a coordinated approach for producing and marketing, promoting partnership, convergence and synergy among R and D, to generate employment opportunities for skilled and unskilled persons. Along with central Government some state are operating this mission, such as Kerala bamboo

mission. Kerala state has constituted bamboo mission in November 2003 with the aim of promoting cultivation of bamboo and cane, upgrading the skills of craftsmen for the production of innovative furniture's and new designs.

EMPLOYMENT POTENTIAL

In India, bamboo currently generates 432 million workdays annually, employing nearly 10 million people (Anonyms). Women constitute a majority in some craft industries, and 50% of a tribal population of 68 million depends on the exploitation of non-timber forest produce like bamboo for their livelihood. With 8.96 million hectares of India's forest covering bamboo, there is potential to create approximately 129 million jobs or, even with more conservative estimates, at least 50 million. In terms of global market shares India contributes only 4.5 percent, while China shares 50 percent of commercial production (Mehra and Mehra 2007).

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